

### Intelligent DTS Solutions for Load Maximization and Hot Spot Detection

#### Overview

Maximizing the current carrying capacity within thermal limits is a principal concern for the design, installation, and operation of reliable transmission cables.

Although cable components have known and repeatable characteristics with respect to their load-temperature relationship, the environment in which the cable operates is often less understood and has a significant influence.

Even with controlled back-fills, this environmental influence not only changes during the day and with seasons (by virtue of the weather) but also varies along the length and life of the cable.

Current carrying capacity (ampacity) calculations during project design provide a theoretical method based on modeling to estimate the maximum load of cables. However, these estimates often incorporate significant safety margins which act to reduce the load which the cable can carry.

One approach is to over-design the circuit based on the worst case conditions but this results in an increase in project cost. Another approach is to ignore the worst-case conditions but this may result in either reduced cable capacity or overheating (resulting in cable loss or life reduction).

A proven and widely accepted solution is the implementation of a fiber-optic Distributed Temperature Sensing (DTS) system. DTS systems effectively and reliably track the real-time dynamic temperature response to load along the complete length of the cable(s). This provides the necessary information to the operator to allow the load to be maximized without exceeding the thermal limit, avoiding cable loss and maintaining cable life.



#### Better Decisions from Better Data

- Provides real-time dynamic temperature information along the full length of transmission cables for load maximization and health monitoring
- Identifies small hot spot locations and temperatures (joint health monitoring for example) with no need of prior knowledge
- Establishes cable thermal profile and footprint
- Provides accurate and actual temperature data for input into dynamic cable rating systems or calculations based on installed conditions
- Provides additional early fire detection in cable tunnels and ducts

#### Intelligent Monitoring Solutions

SensorTran's intelligent DTS monitoring solutions for transmission cables provide real-time dynamic temperature data along the complete length of single or multiple transmission cables. They also provide for localized hot spot detection of cable features such as joints.

These systems measure the temperature for up to up to 40,000 discrete points along a standard telecommunications-grade optical fiber with fine resolution, high accuracy and very fast measurement speeds.

Such systems have an open-communications architecture allowing for reliable and easy interfacing with 3<sup>rd</sup> party systems and networks over, for example, Ethernet, OPC and SCADA.

SensorTran's specifically developed application software presents the data in a meaningful, representative and intuitive graphical form to the operator.

Intelligent alarm types and configurations can be readily tailored to each specific project to alert the operator to both potential and present over-heating and other undesirable health events.

## System Features and Benefits

**SensorTran's** intelligent solutions provide a wealth of features:

- ⇒ up to 50 fiber-optic channels available to provide monitoring for large power cable networks from a single DTS unit
- ⇒ open-communications architecture provides reliable and easy interfacing with 3<sup>rd</sup> party systems and networks (Ethernet, OPC, SCADA, etc) together with flexible remote control and data output/input capabilities
- ⇒ intelligent and multiple alarm types and configurations can be readily tailored to each specific project to alert the operator to both potential and present over-heating and other undesirable health events
- ⇒ each power cable can be defined into unlimited zones with individual alarm types and set-points for each zone, allowing alarms to fully reflect the changing characteristics along its complete length
- ⇒ specifically developed application software presents the data in a meaningful, representative and intuitive graphical form to the operator
- ⇒ wide range of cabinet packages available to meet exacting project requirements
- ⇒ on-board and expandable data storage provides for historical data archiving
- ⇒ Extensive on-board self diagnostics and autonomous operation with safe shut-down and auto-start-up capabilities

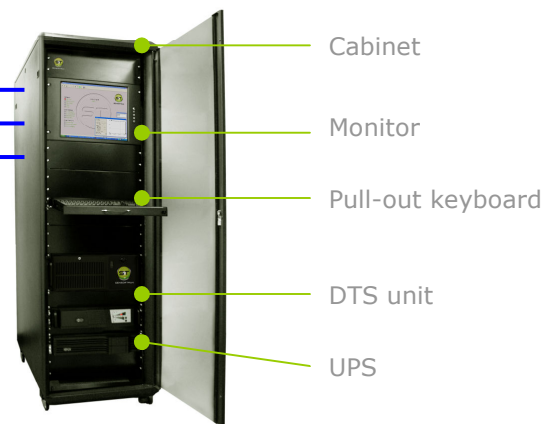
## System Configuration

Single or multiple DTS units can be provided within a single cabinet. A typical single-DTS unit configuration is shown below. DTS networks can also be readily implemented providing expanded coverage for large power cable networks.

Fiber-optic channels: Up to 50 channels can be provided to allow for multiple power cable monitoring in either single-ended or double-ended configuration

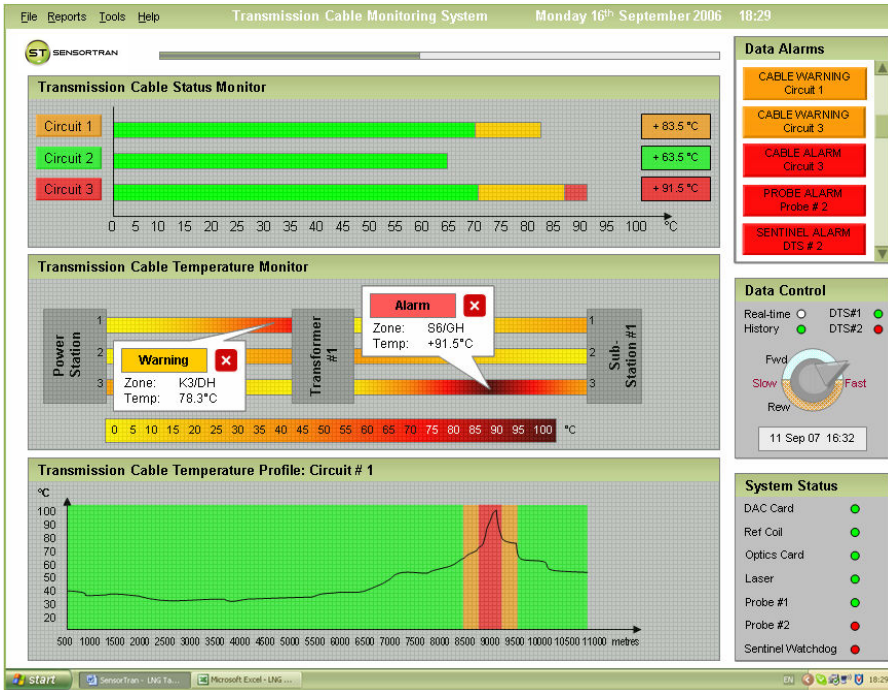


- ◆ Data and alarm output: Ethernet, OPC, SCADA, relay contacts, RS232, RS485, etc
- ◆ Remote control and data input: Ethernet, OPC, SCADA, RS232, RS485, etc
- ◆ Peripheral equipment: printers, remote displays & keyboards, data back-up, etc
- ◆ Extensive historian capability able to replay/revisit alarm events and asset performance



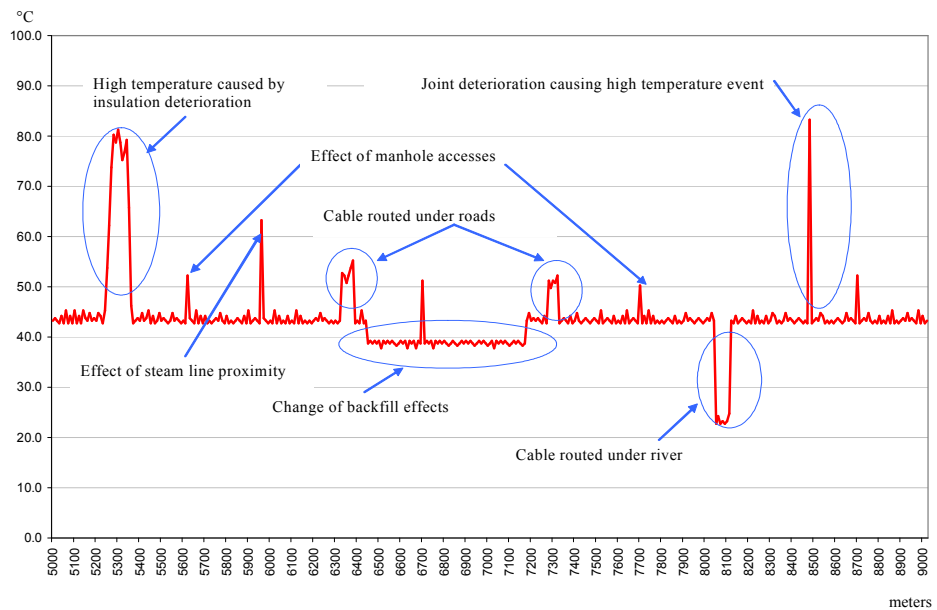
To complement the DTS Manager Software, SensorTran has developed specific application software for the monitoring of transmission cables. This provides the human-machine-interface (HMI) to present the temperature and alarm information to the operator in a clear, precise and intuitive manner. These HMIs are tailored to suit specific project requirements so that they provide an accurate mimic of the installation.

In addition to displaying real-time data, the versatility of these systems also allow for the playback of historical data. Playback direction and review speed is provided by a single control.



Cable condition status, temperature profile of each cable (both as graphical and temperature trace representations) and trend plots for specific points along the cable are clearly displayed.

Multiple data and system health alarms are also displayed.

**Typical Temperature Trace**


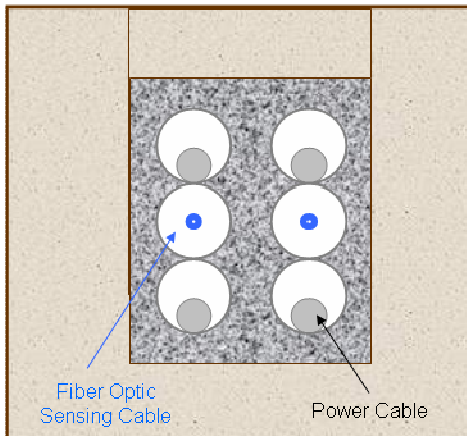
The example at right shows a simple temperature trace along a single power distribution cable, clearly displaying events and features.

## Optical Fiber Installation and Deployment

Optical fiber which is already integrated within the power cable itself can be easily utilized for monitoring. Where this is not the case, optical fiber can be retrospectively secured to the outside of the cable (typically within a stainless steel protective tube).

SensorTran's monitoring solutions can be readily applied to direct buried, duct and tunnel cable installations.

The optical fiber can be configured in either single-ended or double-ended configuration. Double-ended configuration is where both ends of the fiber are connected to the DTS system to form a "loop". This has the additional advantage that in the unlikely event of a fiber-break the power cable can still be totally monitored by the system.



## The SensorTran Advantage

SensorTran, a NASA technology spin-off, is committed to supplying its customers with smart distributed monitoring solutions. SensorTran's systems are conceived to have a low lifetime cost of ownership (LCO) by way of efficient design, superior engineering and reliable construction. SensorTran's team is dedicated to providing "best-in-industry" customer care from project conception to the development of specifications, through installation, training and beyond.

SensorTran has made every effort to ensure information contained in this document is accurate at the time of printing, however, product specifications and features are subject to change without notice.

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